WHAT IS CLAIMED IS:

Sub a1

1. A system for maintaining a background model of an image sequence having a plurality of pixels, comprising:

a pixel processing module that processes the image sequence on a pixel scale; and

at least one refinement module that processes the image sequence on a spatial scale other than the pixel scale.

Sub B1

2. The system of claim 1, wherein the pixel processing module further comprises determining an initial background model and providing an initial pixel assignment to each of the plurality of pixels.

3. The system of claim 1, wherein a first refinement module is a region processing module that processes the image sequence on a regional scale.

4. The system of claim 3, wherein the region processing module further comprises considering a relationship between at least some of the plurality of pixels to provide pixel assignment.

5. The system of claim 3, wherein a second refinement module is a frame processing module that processes the image sequence on a frame scale.

6. The system of claim 5, wherein the frame processing module further determines a background model that most accurately represents an actual background of the image sequence and performs one of: (a) retaining a current background model; (b) substituting a more accurate background model in place of the current background model.

7. The system of claim 5, further comprising a postprocessing module that provides enhancement of the image sequence.

8. The system of claim 7, wherein the enhancement is speckle removal.

9. The system of claim 7, wherein the postprocessing module provides enhancement after the pixel processing module and before the frame processing module.

10. The system of claim 7, wherein the postprocessing module provide enhancement after the frame processing module and before the region processing module.

11. A computer-readable medium having computer-executable modules, comprising:

a pixel processing module that processes the image sequence on a pixel scale; and

at least one refinement module that processes the image sequence on a spatial scale other than the pixel scale.

12. The apparatus of claim 11, wherein the refinement module processes the image sequence on scale larger than the pixel scale.

13. The apparatus of claim 12, wherein a first refinement module is a region processing module that processes the image sequence on a region scale.

14. The apparatus of claim 13, wherein a second refinement module is a frame processing module that processes the image sequence on a frame scale.

15. The apparatus of claim 14, further comprising a postprocessing module that provides enhancement of the image sequence.

Sub A3 16. A method for maintaining a background model of an image sequence having a plurality of pixels, comprising:

processing the image sequence on a pixel scale so as to determine a current background model and provide an initial assignment for each of the plurality of pixels; and

refining the pixel processing by processing on a spatial scale other that the pixel scale to further refine at least one of: (a) the current background model; (b) the initial pixel assignments.

~~17. The method of claim 16, wherein refining further comprises providing a region processing module that processes the image sequence on a region scale.~~

~~18. The method of claim 17, wherein refining further comprises providing a frame processing module that processes the image sequence on a frame scale.~~

~~19. The method of claim 18, wherein refining further comprises providing a postprocessing module that enhances the image sequence.~~

~~20. The method of claim 19, wherein the postprocessing module enhances the image sequence by providing speckle removal.~~

~~21. A system for processing an image sequence having a plurality of frames, each frame containing a pixel, comprising:~~

~~a computation module that provides previous values of the pixel;~~

~~a prediction module that predicts a predicted future value for the pixel using the previous pixel values; and~~

a declaration module that classifies the pixel by comparing the predicted future value to an actual future value of the pixel.

22. The system of claim 21, wherein the computation module provides previous predicted pixel values and previous actual pixel values.

23. The system of claim 22, wherein the prediction module further comprises:

an actual prediction module that predicts the predicted future value using the previous actual pixel values; and

a predicted prediction module that predicts the predicted future value using the previous predicted pixel values.

24. The system of claim 23, further comprising an update module that determines predicted future value having least amount of error and appends this predicted future value to the previous predicted pixel values.

25. The system of claim 21, wherein:

the prediction module uses a prediction technique having prediction parameters to predict the predicted future parameters.

26. The system of claim 25, further comprising a recomputation module that recomputes at least some of the prediction parameters to form new prediction parameters.

27. The system of claim 26, wherein:

the declaration module classifies the pixel as either a background or a foreground pixel; and

the recomputation module is capable of replacing the prediction parameters with the new prediction parameters.

28. A computer-readable medium having computer-executable modules, comprising:

a computation module that supplies previous predicted values of a pixel contained in an image, the previous predicted values comprising previous actual values and previous predicted values of the pixel;

a prediction module that predicts at least: (a) a predicted future value for the pixel using the previous predicted pixel values; and (b) a predicted future value for the pixel using the previous actual pixel values; and

a declaration module that classifies the pixel by comparing at least one of the predicted future values to an actual future value of the pixel.

29. The apparatus of claim 28, further comprising an update module that decides which of the predicted future values has the least error and includes this predicted future value to the previous predicted pixel values.

30. The apparatus of claim 28, wherein the prediction module uses a prediction technique having prediction values to predict the predicted future values.

31. The apparatus of claim 30, further comprising a recomputation module that recalculates at least some of the prediction parameters to form new prediction parameters.

32. The apparatus of claim 30, wherein the prediction parameters are recalculated using the actual future value and the previous actual values of the pixel.

33. The apparatus of claim 32, wherein:

the declaration module classifies the pixel as either a background or a foreground pixel; and

the recomputation module is capable of replacing the prediction parameters with the new prediction parameters.

34. A method of processing an image sequence having a plurality of frames, each frame containing a pixel, comprising:

storing previous values of the pixel;

predicting at least two future values of the pixel using the previous values;

determining an actual value of the pixel; and

comparing the actual pixel value with at least one of the future pixel values so as to classify the pixel.

35. The method of claim 34, wherein storing further comprises storing both of: (a) actual previous pixel values; and (b) predicted previous pixel values.

36. The method of claim 35, wherein future pixel values comprise: (a) an actual future pixel value; (b) a predicted future pixel value.

37. The method of claim 36, wherein:

the actual future pixel value is calculated from the actual previous pixel values; and

the predicted future pixel value is calculated from the predicted previous pixel values.

38. The method of claim 34, wherein comparing further comprises comparing the actual pixel value to both the actual future pixel value and the predicted future pixel value.

39. The method of claim 36, further comprising finding the future pixel value closest in value to the actual pixel value and adding this future pixel value to the predicted previous pixel values.

40. A system for processing an image having pixels, comprising:

an intersection module that groups the pixels to form an intersection image based on an initial classification of each pixel;

a histogram module that determines a property of the pixels within the intersection image to create a boundary of a foreground region; and

a backprojection module that fills in the foreground region within the boundary to segment the foreground region from the image.

41. The system of claim 40, further comprising an image differencing module that identifies moving pixels using a plurality of previous images earlier in time than the image.

42. The system of claim 41, wherein:

the image differencing module takes the difference of the plurality of previous images that are adjacent in time to form a differenced image; and

the intersection module uses the differenced image to form the intersection image that contains moving foreground pixels.

43. The system of claim 42, wherein the intersection module forms the intersection image by calculating the intersection of the differenced image and a foreground image containing pixels classified as foreground pixels.

44. The system of claim 42, wherein the histogram module calculates the property of the pixels in the intersection image.

45. The system of claim 44, wherein the property of the pixels in the intersection image are calculated using pixel property values from a previously processed frame.

46. The system of claim 45, wherein the property of the pixels is at least one of: (a) pixel color; (b) pixel intensity; (c) pixel depth.

47. The system of claim 45, wherein a frequency threshold is defined such that pixels occurring less than the frequency threshold are not included in the foreground region.

48. The system of claim 44, wherein the backprojection module uses connectivity to determine which pixels to include within the boundary.

49. The system of claim 48, wherein connectivity includes finding neighboring pixels with a similar property.

50. The system of claim 49, wherein the amount of connectivity is at least about four.

51. The system of claim 49, wherein the backprojection module further comprises:

entering pixels within the intersection image into a queue;

comparing each pixel's histogram value with a histogram threshold; and

including the pixel within the foreground region if the histogram value is greater than the histogram threshold.

52. A computer-readable medium having computer-executable modules, comprising:

an intersection module that groups pixels in a current frame based on an initial classification of each pixel to form an intersection image;

a histogram module that determines a property of intersection image pixels to form a boundary of a foreground region; and

a backprojection module that connects pixels within the boundary of the foreground region to divide the foreground region from the current frame.

53. The apparatus of claim 52, further comprising an image differencing module that identifies moving pixels using a plurality of frames, each of the plurality of frames being earlier in time that the current frame.

54. The apparatus of claim 53, wherein:

the image differencing module calculates the difference between temporally adjacent frame to form a differenced image; and

the intersection module uses the differenced image to group the pixels.

55. The apparatus of claim 54, wherein the intersection module calculates the intersection of the differenced image and a foreground image containing foreground pixels to form the intersection image containing moving foreground pixels.

56. The apparatus of claim 53, wherein the histogram module calculates a histogram for a property of each pixel within the intersection image.

57. The apparatus of claim 56, wherein the pixel property is at least one of: (a) pixel color; (b) pixel intensity; (c) pixel depth.

58. The apparatus of claim 56, wherein the backprojection module uses connectivity to find neighboring pixels with similar pixel properties.

59. The apparatus of claim 58, wherein the connectivity is at least approximately four.

60. The apparatus of claim 59, wherein the histogram value of each pixel within the intersection image is compared to a histogram threshold and included in the foreground region is the histogram value is greater than the histogram threshold.

61. A method of processing an image containing pixels, comprising:

finding an intersection image within the image using an individual pixel property;

determining a boundary of a foreground region using the intersection image; and

filling in the foreground region within the boundary to segment the foreground region from the image.

62. The method of claim 61, wherein determining a boundary further comprises calculating a histogram for each pixel in the intersection image.

63. The method of claim 62, wherein filling in the foreground region further comprises backprojecting the histogram onto the boundary.

64. The method of claim 63, wherein backprojecting further comprises using connectivity to determine which pixels to include within the foreground region.

65. The method of claim 64, wherein using connectivity comprises comparing a histogram value of each pixel within the intersection image to a threshold and including the pixel within the foreground region is the histogram value is greater than the histogram threshold.

66. The method of claim 65, wherein the connectivity is at least about four.

67. A system for maintaining a background model of an image sequence containing a current frame and previous frames, comprising:

a stored model module that contains a plurality of stored background models;

a background model module that uses the current frame to determine which of a current background model and the plurality of stored background models is the best background model.

68. The system of claim 67, wherein the background model module determines the best background model by finding the background model with the lowest percentage of foreground pixels.

69. The system of claim 67, wherein the stored model module further comprises a frequency module that determines the frequency between testing for replacement of the plurality of stored background models.

70. The system of claim 69, wherein an update frequency of the plurality of stored background models is determined by a percentage of a number of frames required for a pixel to regain stationarity.

71. The system of claim 70, wherein the update frequency has a period of approximately 10 seconds.

72. The system of claim 69, wherein the frequency module determines whether there are enough stored background models.

73. The system of claim 72, wherein the frequency module selects a background model such that the plurality of background models is maximally diverse.

74. The system of claim 69, wherein the stored model module further comprises a benefit module that determines which of the plurality of stored background models should be replaced.

75. The system of claim 74, wherein the benefit module replaces the plurality of stored background models so as to maintain a maximally diverse set of stored background models.

76. The system of claim 75, wherein the benefit module uses a clustering technique to determine which of the plurality of stored background models to replace.

77. The system of claim 76, wherein the clustering technique is a distance metric that determines how close any two stored background models are to each other.

78. A computer-readable medium having computer-executable modules, comprising:

a stored model module that contains a plurality of stored background models; and

a background model module that determines which of a current background model and the plurality of stored background models best represents a background of a current frame.

79. The apparatus of claim 78, wherein the stored module comprises a frequency module that determines an update frequency of the plurality of stored background models.

80. The apparatus of claim 79, wherein the update frequency is determined by a percentage of a number of frames required for a pixel to regain stationarity.

81. The apparatus of claim 80, wherein the update frequency is approximately 10 seconds.

82. The apparatus of claim 80, wherein the update frequency is approximately every 50 frames.

83. The apparatus of claim 79, wherein the frequency module determines whether there are enough stored background models.

84. The apparatus of claim 83, wherein the determination is made by the frequency module to provide a maximally diverse set of stored background models.

85. The apparatus of claim 79, wherein the stored model module further comprises a benefit module that determines which of the plurality of stored background models to replace.

86. The apparatus of claim 85, wherein the determination is made by the benefit module to provide a maximally diverse set of stored background models.

87. The apparatus of claim 86, wherein the benefit module determines which of the plurality of stored background models to replace based on a clustering technique.

88. The apparatus of claim 87, wherein the clustering technique is a distance metric technique.

89. The apparatus of claim 78, wherein the determination of the best representation of the current frame background is made by finding the background model containing the lowest percentage of foreground pixels.

90. The apparatus of claim 89, wherein the foreground pixels are determined using a pixel processing system that provides a classification of a pixel as either a background pixel or a foreground pixel.

91. A method for maintaining a background model of an image sequence, the image sequence having a current frame and a previous frame, comprising:

creating a maximally diverse set of stored background models;

determining whether a current background model adequately represents an actual background of the current frame; and

substituting one of the set of stored background models in place of the current background model if the current background model does not provide adequate representation.

92. The method of claim 91, wherein determining whether the current background model provides adequate representation comprises finding the background model containing the lowest percentage of foreground pixels.